SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Mechanical Engineering
B. Tech. (Mechanical Engg.+ Civil Engg.) Minor I Examination, Feb 2019

Entry No: 1 8 B M E 0 2 9 **Total Number of Pages: [1]**
Date: **Total Number of Questions: [2]**

Course Title: Materials Science & Engineering
Course Code: MEL 1112

Time Allowed: 1.5 Hours **Max Marks: [20]**

Instructions / NOTE

i. Attempt All Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing

	Section A		
Q1.	**(a)** Explain following properties: (i) Hardness, (ii) Fatigue, (iii) Resilience, (iv) Toughness, and (v) Surface roughness.	[5]	CO1
	(b) Draw stress-strain diagram for ductile material. Explain important points in curve.	[1]	CO1
	(c) A cylindrical specimen of a nickel alloy having an elastic modulus of **207 GPa** and an original diameter of **10.2 mm** will experience only elastic deformation when a tensile load of **8900 N** is applied. Compute the maximum length of the specimen before if the maximum allowable elongation is **0.25 mm**.	[2]	CO1
	(d) Classify engineering materials and briefly give the properties of each category.	[2]	CO1
Q2.	**(a)** Derive planar density expression for FCC (100) and FCC (111) planes in terms of the atomic radius R	[4]	CO1
	(b) Sketch within a cubic unit cell the following planes: (i) (0 1bar 1), (ii) (2 1bar 1), (iii) (2bar 1 2), (iv) (1bar 1 1bar)	[4]	CO1
	(c) Sketch within a cubic unit cell the following directions: (i) [100], (ii) [110], (iii) [111], (iv) [1 1bar 0].	[2]	CO1

Course Outcomes

CO1: To understand the fundamental principles conducting and connecting the structure, processing, properties, and performance of materials systems.

CO	Questions Mapping	Total Marks	Total Number of Students (to be appeared in Exam)
CO1	Q1, Q2	20	60+60

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Mechanical Engineering
B. Tech. (Mechanical Engg.+ Civil Engg.) Minor II Examination, March 2019

Entry No: 18BME029
Date:

Total Number of Pages: [2]
Total Number of Questions: [3]

Course Title: Materials Science & Engineering
Course Code: MEL 1112

Time Allowed: 1.5 Hours

Max Marks: [20]

Instructions / NOTE

i. Attempt any two Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing

	Section A		
Q1.	(a) Illustrate eutectoid and peritectic reaction by using Iron-Iron Carbide Phase diagram.	[6]	CO3
	(b) Compute the mass fraction of alpha ferrite and cementite in pearlite.	[3]	CO3
	(c) Explain L Rule.	[1]	CO3
Q2.	(a) Illustrate following terminologies: (i) Edge dislocation, (ii) Screw dislocation, (iii) Mixed dislocation, (iv) Burger vector (v) Twin boundary	[5]	CO2
	(b) Determine the carburizing time necessary to achieve a carbon concentration of 0.30 wt% at a position 4 mm into an iron–carbon alloy that initially contains 0.10 wt% C. The surface concentration is to be maintained at 0.90 wt% C, and the treatment is to be conducted at 1100°C.	[5]	CO2
Q2.	(a) Determine the ASTM grain size number of a metal specimen if 45 grains per square inch are measured at a magnification of 100X. For this same specimen, how many grains per square inch will there be at a magnification of 85 X.	[3]	CO2
	(b) The activation energy for the diffusion of copper in silver is 193,000 J/mol. Calculate the diffusion coefficient at 1200 K (927°C), given that D at 1000K (727°C) is $1.0 \times 10^{-14}\ m^2/s$.	[3]	CO2
	(c) Briefly explain Hume Rothery Rule with example.	[2]	CO2
	(d) Illustrate Fick's second law of diffusion and provide suitable example for supporting your answer.	[2]	CO2

Course Outcomes

CO1: To understand the fundamental principles conducting and connecting the structure, processing, properties, and performance of materials systems.
CO2: To understand the fundamental principles conducting and connecting the structure, processing, properties, and performance of materials systems.
CO3: To understand the importance and uses of Iron Carbon Equilibrium Diagram and Heat Treatment of metals.

CO	Questions Mapping	Total Marks	Total Number of Students (to be appeared in Exam)
CO1	-	-	60+60
CO2	Q2,Q3	10	
C03	Q1	10	

Table 5.1 Tabulation of Error Function Values

z	$erf(z)$	z	$erf(z)$	z	$erf(z)$
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

Table 5.2 A Tabulation of Diffusion Data

Diffusing Species	Host Metal	D_0 (m^2/s)	Activation Energy Q_d (kJ/mol)	(eV/atom)	T (K)	Calculated Value (m^2/s)
Fe	α-Fe (BCC)	2.8×10^{-4}	251	2.60	900	3×10^{-21}
Fe	γ-Fe (FCC)	5.0×10^{-5}	284	2.94	1100	1.8×10^{-16}
C	α-Fe	6.2×10^{-7}	80	0.83	500	2.4×10^{-21}
C	γ-Fe	2.3×10^{-5}	148	1.53	900	5.9×10^{-16}
Cu	Cu	7.8×10^{-5}	211	2.19	1000	4.3×10^{-19}
Zn	Cu	2.4×10^{-5}	189	1.96	500	4.0×10^{-18}
Al	Al	2.3×10^{-4}	144	1.49	500	4.2×10^{-24}
Cu	Al	0.5×10^{-4}	136	1.41	500	4.1×10^{-24}
Mg	Al	1.2×10^{-4}	131	1.35	500	1.9×10^{-23}
Cu	Ni	2.7×10^{-5}	256	2.65	500	1.3×10^{-22}

Source: E. A. Brandes and G. B. Brook (Editors), *Smithells Metals Reference Book*, 7th edition, Butterworth-Heinemann, Oxford, 1992.

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA

School of Mechanical Engineering

B. Tech. (Mechanical Engg.+ Civil Engg.)

Major Examination, May 2019

Entry No: 1 8 B M E 0 2 9

Total Number of Pages: [2]

Total Number of Questions: [8]

Date:

Course Title: Materials Science & Engineering

Course Code: MEL 1112

Time Allowed: 3.0 Hours

Max Marks: [50]

Instructions / NOTE

i. Attempt any five Questions.

ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.

iii. Assume an appropriate data / information, wherever necessary / missing

	Section A		
Q1.	(a) Below is a list of metals and alloy: Plain carbon steel; Brass; Gray cast iron; Platinum; Stainless steel; Titanium alloy; Magnesium; Zinc; Tool steel; Aluminum; and Tungsten. **Select from the list** one metal or alloy that is best suited for each of the following applications, and cite at least two reasons for your choice: **(i)** The block of an internal combustion engine; **(ii)** Condensing heat exchange for steam; **(iii)** Jet engine turbofan blades; **(iv)** Drill bit; **(v)** Cryogenic (i.e., very low temperature) container; **(vi)** As a pyrotechnic (i.e., in flares and fireworks); **(vii)** High temperature furnace elements to be used in oxidizing atmosphere. (b) Provide a comparative study among plastic, composite, and ceramics *(Please support your answer in tabular form with at least five points).*	[7] [3]	CO3
Q2.	Briefly describe the simplest heat treatment procedure that would be used in converting a 0.76 wt% C steel from one microstructure to the other, as follows: **(a)** Martensite to Spheroidite; **(b)** Spheroidite to Martensite; **(c)** Bainite to Pearlite; **(d)** Pearlite to Bainite; **(e)** Spheroidite to Pearlite; **(f)** Pearlite to Spheroidite; **(g)** Tempered Martensite to Martensite; **(h)** Bainite to Spheroidite	*[10]*	*CO2*
Q3.	(a) Write down formula for Brinell hardness Number. (b) Differentiate between Resilience, and Toughness (Five points). (c) Within a unit cell, sketch the following: $[31Bar2],(111),[31Bar3],(110),[2Bar12]$ (d) Explain why hardness test are performed more frequently than any other mechanical test (Five points)	[1] [2] [5] [2]	CO1
Q4.	(a) Differentiate between CCT, and TTT diagram (Five points). (b) Illustrate following terminologies: (i) Austenite, (ii) Ferrite, (iii) Banite, (iv) Pearlite, and (v) Martensite. (Support your answers in terms of Figures, Equations, Compositions, Structures, and Properties). (c) What is the carbon concentration of an iron-carbon alloy for which the fraction of total cementite is 0.10?	[2] [5] [3]	CO2
Q5.	(a) For an ASTM grain size of 6, approximately how many grains would there be per squar inch at (i) A magnification of 100, and (ii) Without any magnification. (b) The diffusion coefficients for nickel in iron are given at two temperatures: T(K) 1473 1673 D(m^2/s) $2.2X10^{-15}$ $4.8X10^{-13}$	[3] [4]	CO1

	(i) Determine the value of D_0 and the activation energy; (ii) What is the magnitude of D at 1300^{0}C (1573K). (c) Analyze how temperature influences creep (Support your answer by equations and diagrams). (d) Calculate the atomic packing factor for the FCC crystal structure	[2] [1]	
Q6.	(a) Draw the structure of Graphite, and Fullerenes. (b) Draw the schematic diagram of the microstructures for an iron-carbon alloy of hypoeuteutectoid composition as it is cooled from within the austenite phase region to below the eutectoid temperature. (c) Analyze how concentration and temperature influence on Cell potential (Please analyze by explaining equations). (d) Illustrate the energy criteria approach for fracture analysis. (e) Explain corrosion and indentify the factors which affect corrosions.	[2] [4] [1] [2] [1]	CO1
Q7.	(a) Illustrate three modes of crack surface displacement by supporting diagram. (b) Differentiate between ductile, and brittle fracture (Five points). (c) A relatively large plate of a glass is subjected to a tensile stress of 40 MPa. If the specific surface energy and modulus of elasticity for this glass are 0.3 J/m^2 and 69 GPa, respectively, determine the maximum length of a surface flaw that is possible without fracture. (d) Explain creep and analyze the typical creep curve of strain verses time. (e) Differentiate between hot working and cold working (Five points).	[2] [2] [2] [2] [2]	CO3
Q8.	(a) Explain different types of corrosions and protective measures to check the corrosion. (b) Differentiate between slip and Twinning deformation mechanism with reference to mechanism and condition causing deformation. (c) A single crystal of a metal that has the FCC crystal structure is oriented such that a tensile stress is applied parallel to the [100] direction. If the critical resolved shear stress for this material is 0.5 MPa, calculate the magnitude of applied stress necessary to cause slip to occur on the (111) plan in each of the [1 1bar 0], [1 0 1bar] and [0 1bar 1] direction.	[5] [2] [3]	CO1

Course Outcomes

CO1: To understand the fundamental principles conducting and connecting the structure, processing, properties, and performance of materials systems.
CO2: To understand the importance and uses of Iron Carbon Equilibrium Diagram and Heat Treatment of metals.
CO3: To be able to select materials for design of mechanical components and understand the contemporarily issues relevant to materials science and engineering.

CO	Questions Mapping	Total Marks	Total Number of Students (to be appeared in Exam)
CO1	Q3, Q5, Q6,Q8	40	60+60
CO2	Q2, Q4	20	
CO3	Q1	10	